NASA TECH BRIEF

Digital Computer Program Predicts Effects of Local Pressure Transients on Deformation and Stresses in Cylindrical Ducts

The problem:

During the various phases of operation of the propulsion systems of space vehicles, severe pressure transients are experienced by the component cylindrical ducts. A study was conducted to determine the dynamic response of circular cylinders subjected to pressure transient forms commonly encountered in propulsion systems with the prime objective of providing analytical procedures and design charts capable of dealing with the stringent minimum weight requirements of aerospace vehicles.

The solution:

In general, a method is developed for the solution of the basic equation for circular cylinders subjected to axial symmetric pressures of any type. However, the method was used in this study to obtain dynamic solutions to the more common pressure transient types and the pertinent stresses required for minimum weight design purposes summarized into design charts.

In the course of the study, a literature survey revealed that although the basic equations for the problem at hand are well defined, pertinent dynamic solutions and their application to predicting the correct local stress fields in cylinders subjected to transient pressures were limited.

How it's done:

Transient pressures appear in the form of pressure or rarefaction waves which propagate along ducts at approximately the speed of sound in the contained fluid. These pressure waves have various forms which depend on the nature of the disturbance responsible for them. All dynamic elastic solutions obtained are based on the assumption that the form and velocity of propagation of the pressure transients are known.

The basic equations used in the analysis are provided. Two solutions are then obtained for the infinite shell, one for the spike load and the other for the step pressure form. In addition, a method for deriving the dynamic response with damping of a finite length duct subjected to axial symmetric pressures is developed. For illustrative purposes, several problems are solved in detail. The work is limited to two boundary conditions, i.e., cylinders with both ends simply supported and cylinders with both ends fixed. Although it is shown that the method can be readily used to obtain solutions for all possible combinations of admissible boundary conditions, the two selected boundary conditions are deemed sufficient for practical reasons.

Notes:

1. This program is written in Fortran IV for the IBM 7094 computer.
2. Inquiries concerning this program should be directed to:

   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B67-10631

Patent status:

No patent action is contemplated by NASA.

Source: W. Luberacki, J. Padlog, H. Reismann, and Y. Echenoz
of Bell Aerosystems
under contract to
Marshall Space Flight Center
(MFS-13058)

Category 06